

Claims

We Claim:

- 5 1. A semiconductor ESD structure comprising:
 a semiconductor substrate of a first conductivity type
 having a first region of a second conductivity type and a first
 dopant concentration;
 a buried region of the second conductivity type formed in
10 the first region;
 a second region of the first conductivity type formed in the
 first region and contacting the buried layer;
 a third region of the first conductivity type formed in the
 first region and contacting the buried layer;
15 a first isolation region formed in the first region between
 the second and third regions;
 a first pair of oppositely doped regions formed in the
 second region; and
 a second pair of oppositely doped regions formed in the
20 third region.
2. The structure of claim 1 wherein the second and third
 regions and the first isolation region form concentric rings in
 the first region.
- 25 3. The structure of claim 1 wherein the first isolation
 region comprises a diffused region having a second dopant
 concentration greater than the first dopant concentration.
- 30 4. The structure of claim 3 wherein the first isolation
 region has a surface dopant concentration of greater than about
 1.0×10^{18} atoms/cm³.
5. The structure of claim 1 wherein the first isolation
35 region extends through the first region and contacts the buried
 region.

6. The structure of claim 1 wherein the first region comprises an epitaxial layer.

7. The structure of claim 1 wherein the first pair of oppositely doped regions are shorted together.

8. The structure of claim 1 wherein the second pair of oppositely doped regions are shorted together.

9. The structure of claim 1 further comprising:
a second isolation region formed in the first region adjacent the second region; and
a third isolation region formed in the first region adjacent the third region.

10. The structure of claim 9 wherein the second and third isolation regions extend to the buried region.

11. The structure of claim 1 wherein one region of the first pair of oppositely doped regions has a resistance that is about twice that of the other region in the first pair.

12. The structure of claim 1 wherein one region in the second pair of oppositely doped regions has a resistance that is about twice that of the other region in the second pair.

13. The structure of claim 1 further comprising a fourth isolation region formed in the first region and surrounding the buried region, the second and third regions, and the first isolation region.

14. The structure of claim 1 wherein the buried region, the second region, and the third region form a temperature compensated device.

15. The structure of claim 1 wherein the buried region and the second region form a buried avalanche region.

16. The structure of claim 1 wherein the buried region and the third region form a buried avalanche region.

17. The structure of claim 1 whereon one of the first pair of oppositely doped regions and the second pair of oppositely doped regions is shorted together to provide a reduced capacitance device.

18. The structure of claim 1 wherein the buried region and the second region generate a V_{BE} voltage and the buried region and the third region generate an avalanche voltage during an ESD trigger event.

19. The structure of claim 1 wherein the buried region and the third region generate a V_{BE} voltage and the buried region and the second region generate an avalanche voltage during an ESD trigger event.

20. A semiconductor device comprising:

a first ring region of a first conductivity type formed in a layer semiconductor material of a second conductivity type and having a first doping concentration;

a second ring region of the first conductivity type formed in the layer of semiconductor material;

a first doped region of the second conductivity type within the layer of semiconductor material and coupled to the first and second ring regions; and

a third ring region comprising an isolation region between the first and second ring regions.

21. The device of claim 20 wherein the third ring contacts the first doped region.

22. The device of claim 20 further comprising:
a second doped region of the first conductivity type formed
in the first ring; and
a third doped region of the second conductivity type formed
5 in the first ring.

23. The device of claim 22 further comprising:
a fourth doped region of the first conductivity type formed
in the second ring region; and
10 a fifth doped region of the second conductivity type formed
in the second ring region.

24. The device of claim 20 further comprising:
a first contact structure coupled to the first ring region;
15 and
a second contact structure coupled to the second ring
region.

25. The device of claim 24 wherein one of the first and
20 second contact structures includes a polycrystalline
semiconductor material.

26. The device of claim 20 wherein the first doped region
comprises a buried region.
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27. The device of claim 20 further comprising a fourth ring
region comprising an isolation region formed in the layer of
semiconductor material adjacent the first ring region and
contacting the first doped region.
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28. The device of claim 20 further comprising a fifth
region comprising an isolation region formed in the layer of
semiconductor material adjacent the second ring region and
contacting the first doped region.
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29. The device of claim 20 wherein the first, second, and third ring regions are substantially concentric.

30. The device of claim 20 wherein the third ring region
5 comprises a diffused region having a second dopant concentration greater than the first dopant concentration.

31. The device of claim 20 wherein one of the third ring
10 region, fourth ring region, and fifth ring region comprises a passivated trench.

32. A method for forming a semiconductor device comprising the steps of:

15 forming a first ring region of a first conductivity type in a layer semiconductor material of a second conductivity type and having a first doping concentration;

forming a second ring region of the first conductivity type in the layer of semiconductor material;

20 forming a first doped region of the second conductivity type within the layer of semiconductor material and coupled to the first and second ring regions; and

25 forming a third ring region of the second conductivity type between the first and second ring regions, wherein the third ring region has a second doping concentration greater than the first doping concentration.

30 33. The method of claim 32 wherein the step of forming the third ring includes forming the third ring coupled to the first doped region.

34. The method of claim 32 further comprising the steps of:
forming a second doped region of the first conductivity type in the first ring region;

35 forming a third doped region of the second conductivity type in the first ring region;

forming a fourth doped region of the first conductivity type in the second ring region; and

forming a fifth doped region of the second conductivity type in the second ring region.

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35. The method of claim 34 wherein the steps of forming the second and fourth doped regions include:

depositing a polycrystalline semiconductor layer over the body of semiconductor material;

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diffusing first conductivity type dopant from the polycrystalline semiconductor layer into the first and second ring regions to form the second and fourth doped regions.

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36. The method of claim 34 wherein the steps of forming the first and third doped regions include:

depositing a polycrystalline semiconductor layer over the body of semiconductor material;

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diffusing second conductivity type dopant from the polycrystalline semiconductor layer into the first and second ring regions to form the first and third doped regions.

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37. The method of claim 32 further comprising the steps of: forming a first contact structure coupled to the first ring; and

forming a second contact structure coupled to the second ring.

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38. The method of claim 32 further comprising the steps of: forming a fourth ring region of the second conductivity type in the layer of semiconductor material adjacent the first ring region and coupled to the first doped region; and

forming a doped region of the second conductivity type in the layer of semiconductor material adjacent the second ring region and coupled to the first doped region.